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ESCUELA POLITÉCNICA SUPERIOR Alicante University

Carretera San Vicente del Raspeig s/n 03690 San Vicente del Raspeig. Alicante (SPAIN)

eurau@ua.es

Ecological Footprint to Assess Sustainability of Educational Campuses

University of Kurdistan as a Case

Hamed Abdi, Mohammad[1]
1. Escuela Técnica Superior de Arquitectura de Madrid, Universidad Politécnica de Madrid, Spain, mh.abdi@alumnos.upm.es

Synopsis

The Ecological footprint (EF) has been increasingly acquired attention as an index to measure the sustainable development during last decades. It was originally emerged as a measure of sustainability since it highlights biophysical limits of the consumed resources. In general, educational campuses usually encompass ample areas, and are associated with diverse disposal resources and consumption patterns. The study seeks to measure EF index as an effective indicator for University of Kurdistan Campus (UOKC) in Iran, consider appropriate methods all to gain specific values, and provide useful information available for the university community in terms of the environmental respects. To do so, this paper involves a componential method of the EF to calculate the UOKC's EF level. The Results demonstrated that the largest component was the EF level of energy, accounting for 44.52% of the total EF, then, the EF level of wastes, and the EF level of the traffic located second and third level respectively. All in all, regarding the results, UOKC can be assessed as unsustainable area thanks to the total EF which is high at roughly 66.8 times larger than its own campus' area.

Key words: Sustainable Development, Ecological footprint, University of Kurdistan campus.

1. Introduction

By the end of the 20th century, in response to a growing environmental crisis and inequalities in global development, Sustainable Development (SD) was widely adopted by the international community as a leading development model. It insists on maintaining natural capitals since the consumption is dependent on the availability of renewable resources (Bicknell et al, 1998). To measure sustainability, much have been done on such predictor indicators as Sustainable Socio-Ecological Indicator (Christian, 1996), Index of Sustainable Economic Welfare (ISEW ((Daly and Cobb, 1989), Genuine Progress Indicator (GPI) (Anielski and Rowe, 1999) and Genuine Savings Rates (World Bank, 2000) and so forth. Amongst them, Ecological Footprint Assessment (EFA) was applied as a method in the 1990s to measure SD. The foot printing process can help researchers to find some of the "hidden" environmental costs imposed by the consumptions pattern (Venetoulis, 2001). There has been an increasing focus on the evaluation of environmental performance of businesses, organizations, and governmental institutions as a means to channel environmental management efforts (Lenzen et al, 2010). Perfect examples of such institutions to which many attentions belong are educational campuses. This has increasingly highlighted by such specific conferences as (EMSU) and several rankings (e.g., EESD) on the campuses[1] environmental performance (Ferrer-Balas et al, 2010). Most of these initiatives follow three broad scopes: (i) determining role of the universities in knowledge-extension, (II) integrating sustainability into educational and research plans, and (III) Setting environmental issues significance in the society (Stephens and Graham, 2010; Waas et al, 2010). A number of campuses have diversely published EFA studies (Conway et al, 2008; Dawe et al, 2004; Flint, 2001; Li et al, 2008; Venetoulis, 2001). So, as case- based study, the research focuses on the UOKC, as a regional ample-sized one in Iran, to assess environmental impacts and determine the level of sustainability there in 2013 using EFA.

2. Literature Review

Sustainability is a key issue for all organizations in the 21st century (Rusinko, 2010). As a specific community, the universities cannot neglect the issue of sustainability. Beringer et al (2008) recognized that sustainability is an important issue for universities around the world as well. Every year, the number of students who further their studies at universities is increasing. D'Amico and Brooks (1968) pointed out that regarding population growth and industrial and technological development, the universities should follow a long-term strategic development plans to meet the essential needs of today while paying much attention to the probable impacts of the campuses (D'Amico and Brooks, 1968). Thus, the formation of a sustainable campus can provide opportunities for higher education institutions that show the progressive principles and be a model to the larger community (Franklin et al., 2003). Based on these facts, it is highly probable that the sustainable campuses will impress cities in many ways. These will show us that how much is important to follow the idea of a sustainable campus, as it could be the basis of a broader urban

[1] Environmental Management for Sustainable Universities
[2] Engineering Education for Sustainable Development

sustainable development concept. Concerning these points, there are different definitions to clarify the notion of sustainable campus. These can be illustrated by such keywords as lower negative impacts, healthy ecosystems, economic growth, social promotion, people well- being, conserved ecologically at universities (Cole, 2000; Habib and Alshwaikhat, 2008). Regarding them, it could be inferred that sustainable campus is a notion that describes a special type of university development that seeks to improve the quality of human life in general, and focus on a set of balanced social, ecological and economic goals in particular.

To measure the degree of sustainability of campuses, EF has gained much more attention in the academic communities since being out by Wackernagel and Rees in the 1996 (Erb, 2004). As a definition it can be described as “The corresponding area of productive land and aquatic ecosystems required to produce the resources used, and to assimilate the waste produced, by a defined population at a specified material standard of living, wherever on Earth that land may be located” (Rees, 1996). To facilitate the complex analysis, Wackernagel and Rees constructed a matrix titled as Consumption–Bio Productive Area listing five major consumption categories in conjunction with six major bio productive area categories. Consumption categories include food, housing, transportation, consumer goods and services, while bio productive areas, which refers to all areas that contribute to bio capacity (Wackernagel et al., 2004), include energy land, built-up land, fisheries, cropland, pasture and forest (Bicknell et al., 1998). The calculation procedure proposed by Wackernagel team imports statistics of consumption and population to estimate the ‘average person's’ annual consumption for several items in each of its categories. The total per capita EF can be finally achieved by summing all ecosystem areas dedicated to each item consumed during a particular period (Bicknell et al., 1998). Several organizations have already calculated the EF at different scales, ranging from individual (Friedland et al., 2003), organization (Barrett and Scott, 2001), urban (Folke et al., 1997; Muñiz and Galindo, 2005), regions (Ferng, 2001; Knaus et al., 2006), nations (Wackernagel and Rees, 1996) to worldwide (Loh, 2002). Over last years, the EF evaluation has been transformed to such smaller scales as universities (Flint, 2001; Bell et al, 2008; Venetolis,2001) or even urban schools (Gottelib et al, 2012). According to them, it is assumed that main components for EF calculation at universities would be energy, traffic, waste discard, food and paper.

3. Material and Methods

3.1. Study Area

The campus, located in the south of Sanandaj, consists of 10,000 full-time students, 206 faculties, and 192 staffs in 2013 (Fig. 1). It demarcated 91.7 ha land area including the built environments, parking lots, roads and impermeable pavements.

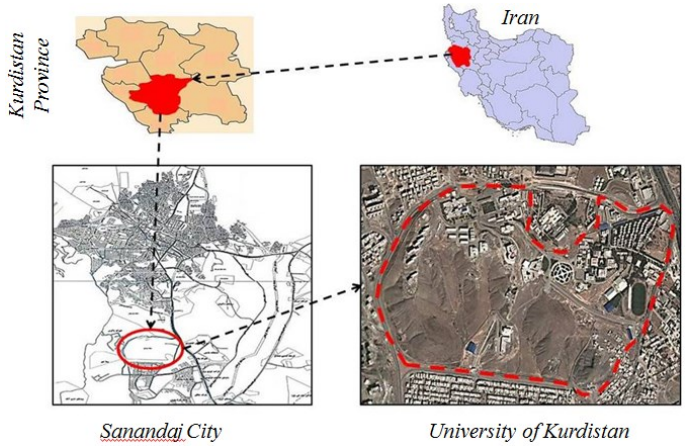

Fig.1 The campus location in Sanandaj, Iran

3.2. Data Collection

The data of electricity, natural gas, coal, water, food consumption and wastes were directly obtained from logistic management office at the campus. Besides, the data of transportation, paper consumption and the component of wastes were indirectly gathered by the questionnaires. The table below explains the data necessary for EF calculation including all kind of consumptions and wastes.

Table1. Consumptions and wastes data for UOK

Component		Total
Energy	Electricity	5199000 kwh
	Nature gas	649875ft^3
Water		155970m^3
Waste discard	Paper and textiles	3899.25t
	Garden and park waste and other(non-food)	95t
	Food waste	1299.75t
	Glass waste	129t
	Plastic waste	26t
Traffic	Car	51990km
	Truck	12997km
Food	Non-beeves, non-mutton	64987.5kg
	Cereals	31194kg
	Fruit	28594.5kg
	Sugar	5458kg
	Vegetable	6498kg
	Eggs	1169.7
	Beeves, mutton	9358.2kg
	Milk	3379.32kg
	Marine fish	2209.75kg
Paper		311.95t
Campus area		**ha**

4. Results and Discussion

The paper aims to calculate EF of UOKS and analyze the different components of UOK's EF using the componential method. The results of EF calculations are as follow in Table 2.

Table2. Ecological foot print of UOK

Component		EF(ha)		EF per capita(ha)
Energy	Electricity	2599.5	2729.47	0.26
	Nature gas	129.97		
Water		15.59		0.001
Waste discard	Paper and textiles	1052.78	1471.5	0.14
	Garden and park waste and other(non-food)	11.4		
	Food waste	129.98		
	Glass waste	245.1		
	Plastic waste	32.24		
Traffic	Car	1.56	2.85	0.0002
	Truck	1.29		
Food	Non-beeves, non-mutton	844.84	1191.69	0.11
	Cereals	9.36		
	Fruit	2.86		
	Sugar	0.27		
	Vegetable	0.32		
	Eggs	2.34		
	Beeves, mutton	280.75		
	Milk	6.76		
	Marine fish	44.195		
Paper		627.01		0.06
Campus area		91.7		0.009
Total EF		6129.81		0.59

According to the table above, the largest component was EF estimated for energy, accounting for 44.52% of the total amount, and EF of traffic is the least one. The EF of waste discard is approximately 16 times bigger than own campus' area. However, an average of 0.5 tons of waste foods has been producing every day. To make impacts reduction, attracting attentions to UOK's consumption pattern regarding saving food strategies could reduce the negative impacts on the environment imposed by the food-based activities. Staying focused on the waste calculation; it became clear that just small part of the waste materials has been recycled. In fact, a meaningful reduction of the waste-based footprint could be made through a rough concentration among students and staffs on recycling waste materials. The EF related to the traffic showed the smallest level among all components during the calculation. According to growing increase of car use in urban areas, there is a fair chance that car-oriented campuses will be resulted in future, just similar to what has happened in the developed countries. Therefore, it is expected that the impacts of traffic tend to be consequently strengthened.

Compared to the other research's results, it can be found that the largest component of EF in all four campuses in UOK, Northeastern University, Colorado College and Redlands University was energy (Table 3). Although Northeastern University applies coal as a direct energy, others including UOK mostly use electricity (indirect energy) instead. Regarding electricity, EF in Colorado College was very large, accounting for 80%, while UOK, Northeastern University and Redlands University were 42.41%, 13.49% and 31.4% respectively. By looking at traffic, Redlands University placed first position at

32.46%. EF calculation for food also showed higher rate compared to the other components and institutions so that went up to about 20% of total EF.

Table3. Ecological footprint of UOK compared with other universities

Component	UOK		Colorado college		Redlands university		Northeastern university	
	EF(ha)	Total EF (%)	EF(ha)	Total EF (%)	EF(ha)	Total EF (%)	EF(ha)	Total EF (%)
Coal	-	-	-	-	-	-	13477.7	54.37
Electricity	2599.5	42.41	4463	80	724.7	31.4	3343.6	13.49
Nature gas	129.97	2.12	395	7	431.2	18.68	27.9	0.11
Food	1191.69	19.44	574.1	10	113.4	5	5405.7	21.81
Waste	1471.5	24	-	-	289.5	12.46	1422.9	5.74
Paper	627.01	10.23	-	-	-	-	490.5	1.98
Water	15.59	0.25	56.5	1	-	-	489.4	1.97
Traffic	2.85	0.05	78	1.4	749	32.46	19.3	0.08
Campus area	91.7	1.49	36	0.6	-	-	110	0.44
Total	6129.81	100	5602.6	100	2307.7	100	24786.9	100

5. Conclusion

Universities could be considered just like an urban neighbourhood or small city due to the scale, population, traffic and so forth. They contain a range of building types including offices, classrooms, hostels, laboratories, health care centres, sport fields and big halls. These all should be assessed permanently in terms of sustainability since they consume a considerable amount of paper, energy and water. This research aimed at pondering the sustainability situation at University of Kurdistan central campus using EF indicator. The results based on statistics obtained from data collected in 2013 displayed that EF level were 61298100 hectares per year, to which equals 0.61 ha per student a year. Like other organizations, universities have an important ecological imperfection, as it tends to occupy a surface of nearly 91.7 hectares. According to the results, emissions from two students would be absorbed by more than one hectare of average world forest. The largest part was the EF level for energy, accounting for 44.52% of the total EF, then, EF calculated for wastes, and EF of traffic can be finally the least. Comparing the result with other universities showed that the EF of UOKC is even larger than Colorado College and Redlands University and a bit less lower than Northeastern Uni-versity in U.S.

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Biography

Mohammad Hamed Abdi. Enthusiastic granted PhD researcher interested in sustainability-based strategies and methods in urban studies in general. He used to focus on different applied and scientific projects in which urban issues and sustainable ideas bridged strongly. Sustainable movement, Transit-oriented development, smart city, nature- based solutions and urban greenery are perfect example of this. In several collaborative works with his colleague, Hamed have already tried to expand the Ecological Footprint Assessment (EFA) index in urban studies of Iranian cities at such different places as museum, high school, university, urban neighborhood and subjects as urban transportation.